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WITNESS my hand this
Twelfth day of September 2003

JONNE YABSLEY
TEAM LEADER EXAMINATION
SUPPORT AND SALES

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Regulation 3.2

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Invention title: **Improvements in or relating to Fire Fighting Apparatus**

The invention is described in the following statement:

Improvements in or relating to Fire Fighting Apparatus

Field of the invention

The present invention is directed to improvements in or relating to fire fighting apparatus, and is more particularly directed to buckets which are capable of being suspended from aircraft for dumping water on forest fires.

Background of the invention

In this specification, where a document, act or item of knowledge is referred to or discussed, this reference or discussion is not an admission that the document, act or item of knowledge or any combination thereof was at the priority date:

(i) part of common general knowledge; or

(ii) known to be relevant to an attempt to solve any problem with which this specification is concerned.

Fire fighting buckets carried by an aircraft such as a helicopter are well-known, and have been used with success in controlling fires in many countries including Australia, the United States and Canada.

In general, a bucket of this nature is suspendible from a helicopter by a sling or harness and, by virtue of its open-topped and closed bottom construction, is capable of being filled with water from an available water source such as a lake, dam, river or ocean by the lowering of the bucket into the water source. When filled, the bucket is raised and the pilot transports the bucket to the site of the fire, following which the water is discharged onto the fire by remote activation by the pilot of a valve in or near the region of the base of the bucket.

Typical examples of such buckets can be found in the disclosures in US Patent Nos 3,661,211, 4,474,245, 4,576,287 and 5,560,429.

US Patent No 3,661,211 for example discloses a flexible open-topped bucket having a pair of pneumatic-ram operated doors which open upwardly to release the contents of the bucket. The ram-operated doors are in the form of a 'plunger-type' valve or 'gate' valve operated by a fluid-operated ram connected to a pressurized fluid source in the helicopter.

Because the valves are typically hydraulically or electrically actuated, they are heavy and prone to failure. The nature of this arrangement is also such that it is capable of only a single water drop, which only enables a fixed amount of water to be dumped on the

fire, and necessitates more frequent returns by the pilot to the water source to refill the bucket.

If a fire is raging in a remote location with restricted or no access to a readily available source of water, this will naturally increase the number of trips the pilot has to make back and forth from the fire to the water source.

This can severely impact on the effectiveness of this fire-fighting technique, and also increases the cost of the helicopter being in the air, the potential risk to the pilot through fatigue, the possibility of equipment failure, greater use of fuel and so on.

It will be understood that dumping a fixed amount of water on a fire which may only require a fraction of the fixed amount in order to be effective, is an inefficient use of this resource, and may lead to a different but no less harmful type of damage to the environment.

The disclosures in US Patents Nos 4,474,245, 4,576,287 and 5,560,429 describe a flexible bucket where the 'plunger-type' valve is replaced with a 'sleeve-type' dump valve. A tubular extension made of the same pliable material as the bucket extends from an opening in the bottom of the bucket to a free end formed with a discharge port to serve as a dump valve. The discharge port has a circumferential sealing lip made of soft resilient material which forms two opposite lip portions that are brought into sealing engagement with each other to minimize water leakage from the tubular extension when the sleeve is held raised within the bucket.

To dump the water, the sleeve is released by loosening purse lines by a release mechanism, causing the sleeve to fall quickly through the opening in the bottom of the bucket. The lip portions are opened simultaneously under the weight of the water, permitting a rapid discharge of the water. This type of bucket arrangement is typically referred to in the industry as a Bambi Bucket™.

Although buckets of that configuration are said to have been very successful, the sleeve-type dump valve is a single action valve whereby the bucket releases all of its load in a single discharge. Accordingly, it cannot be closed during discharge to allow for a second discharge at a remote location. This again leads to inefficient use of water and helicopter time, necessitating more frequent visits to the water source to fill the bucket.

In addition, the relatively soft sealing material of the lip portions of the discharge port can wear rapidly after many deployments of the valve due to the abrasion of the purse lines. The wear is likely to result in loss of sealing effectiveness and resultant leakage through the dump valve.

One attempt at addressing this problem is disclosed in US Patent No 5,829,809, which is said to permit the discharge of two separate loads from a single filling of the bucket by having an outer bucket with an outer sleeve-type dump valve and an inner bucket with an inner sleeve-type dump valve, the inner bucket being located within the outer bucket.

Such an arrangement is however likely to suffer from ineffective filling of both buckets because the inner bucket rests inside the outer bucket. In addition, as observed above, the relatively soft sealing material of the lip portions of the discharge port can wear rapidly after many deployments of the valve due to the abrasion of the purse lines. The wear is likely to result in loss of sealing effectiveness and resultant leakage through the dump valve.

There is also some risk of tangling of the purse lines.

A further problem with prior art buckets described above is that the bucket load can only be controlled manually by means of a cinch strap. This strap passes circumferentially around a portion of the bucket approximately midway and passes through a plurality of loops provided on the inner surface of the side wall. The load in the bucket is controlled by varying the tightness of the strap.. This requires the helicopter pilot to land the helicopter and tighten or loosen the cinch strap manually. It is time consuming, and necessitates the pilot having to find suitable terrain on which to land, leading to increased risk to the pilot.

Zipper or slide fasteners in the side walls of the bucket in order to control the magnitude of the load being carried have been proposed as an alternative to the cinch strap – see for example US Patent No 3,661,211. Zipper fasteners however suffer from the same disadvantage as cinch straps – they require the pilot to engage in a manual manipulation of the fasteners on the ground.

Summary of the invention

The present invention accordingly provides in one embodiment a fire fighting apparatus comprising:

(a) a bucket capable of being suspended from an aircraft, the bucket having an open upper end to enable the bucket to be filled, and

(b) a remotely actuated valve located in the region of the base of the bucket for permitting a controlled volume of the bucket load to be discharged by the aircraft pilot.

A particular advantage of this embodiment of the invention is that the valve can be repeatably opened or closed during transportation of a single bucket load to permit water to be discharged from the bucket at multiple sites of a fire.

The valve and bucket of this embodiment may be as described herein.

The present invention provides in another separate embodiment a fire fighting apparatus comprising:

(a) a tapered bucket capable of being suspended from an aircraft, the bucket having an open upper end to enable the bucket to be filled;

(b) a resiliently flexible valve located in the region of the base of the bucket for permitting the contents of the bucket to be discharged from the bucket remotely by the aircraft pilot, the valve being sufficiently flexible to enable water to be discharged from the bucket when the valve is opened in a bucket discharge phase.

The valve will typically have a substantially planar body.

Preferably the valve is capable of being distorted so as to produce a venturi effect, or an effect approximating a venturi effect, in part of the bucket.

The arrangement of this embodiment is preferably such that a venturi throat is formed between a side wall of the bucket and the valve when the valve distorts under water pressure in the bucket discharge phase.

The bucket and the valve may be selectively movable relative to one another. The bucket and the valve may accordingly be actuated independently of one another.

In a particularly preferred embodiment, a line, stay or cable is attached to the valve and to the aircraft, but is not otherwise attached to the bucket. In this embodiment, separate lines, stays or cables are provided for attaching the bucket to the aircraft. This allows for independent relative movement of the bucket with respect to the valve and vice versa.

In a filling or transport phase, the valve stay and the bucket lines will typically be held in a fixed position relative to one another.

In a bucket discharge phase, the bucket lines are slackened or extended remotely by the pilot so that the bucket falls relative to the valve. By virtue of the fixed position of the valve in space relative to the bucket and by virtue of the tapering of the bucket, a gap forms between the outer periphery of the valve and a side wall of the bucket. The weight of the water which starts to pass through the gap has the effect of distorting the valve

periphery in a downward direction, creating an effect approximating a venturi effect in the region between the valve periphery and a side wall of the bucket.

In an alternative arrangement, in a bucket discharge phase, the valve stay is shortened so that the valve is drawn upwardly relative to the bucket. By virtue of the fixed position of the bucket in space relative to the valve and by virtue of the tapering of the bucket, a gap forms between the outer periphery of the valve and a side wall of the bucket. The weight of the water which starts to pass through the gap has the effect of distorting the valve periphery in a downward direction, creating an effect approximating a venturi effect in the region between the valve periphery and a side wall of the bucket.

Correspondingly, as the level, and hence the weight, of water in the bucket subsides, the valve periphery will generally become less distorted, leading to a lower rate of discharge through the gap between the valve periphery and a side wall of the bucket. Eventually the valve will be caused to return to its rest configuration when the discharge phase is terminated either by adjustment of the bucket relative to the valve or when the bucket is drained of water.

Control of the discharge from the bucket may accordingly be achieved by remote tensioning or slackening of the cables, lines or stays attached to the bucket or to the valve.

The present invention provides in another separate embodiment a fire fighting apparatus comprising:

(a) a bucket capable of being suspended from an aircraft, the bucket having an open upper end to enable the bucket to be filled;

(b) a valve located in the region of the base of the bucket for permitting the contents of the bucket to be discharged remotely by the aircraft pilot, and.

(c) sensing means to dynamically sense the weight of the bucket to enable the bucket to be filled or discharged to a pre-determined volume by the pilot.

The present invention provides in another separate embodiment a fire fighting apparatus comprising:

(a) a bucket capable of being suspended from an aircraft, the bucket having an open upper end to enable the bucket to be filled;

(b) a valve located in the region of the base of the bucket for permitting the contents of the bucket to be discharged remotely by the aircraft pilot, and.

(c) sensing means to dynamically sense the level of water in the bucket to enable the bucket to be filled or discharged to a pre-determined volume by the pilot.

A particular advantage of the latter two embodiments of the invention is that the pilot can control from his/her cockpit the amount of water the bucket is to be filled with. This gives the pilot a significant degree of flexibility in being able to use the bucket in most environments. It will be understood for example by those skilled in the art that at high altitudes where the air is thinner, a helicopter is less able to carry a full load than when near sea level. In a number of countries fires occur at quite high altitudes above sea level. The ability to control the volume of water the pilot picks up in the bucket means that this embodiment of the invention can be used effectively in environments that would otherwise provide severe limitations for prior art buckets.

The valve and bucket of these embodiments may be as described herein.

It has also been observed that a practice commonly adopted by operators of bucket-type fire fighting apparatus is to add a chemical fire retardant such as a foam to the inner walls of the bucket with a view to enhancing the effectiveness of this fire-fighting technique.

A potentially serious downside of this practice is the potential for the chemical retardant to contaminate the water source when the bucket is lowered in to the water source. This can have environmental consequences in damage to the waterway, surrounding flora and fauna, and to the communities which may use the water source for drinking and/or for recreation.

The present invention accordingly provides in another separate embodiment a fire fighting apparatus comprising:

(a) a bucket capable of being suspended from an aircraft, the bucket having an open upper end to enable the bucket to be filled;

(b) a valve located in the region of the base of the bucket for permitting the contents of the bucket to be discharged from the bucket remotely by the aircraft pilot, and;

(c) a reservoir for a fire retardant, the reservoir having release means which when activated permits the flow of retardant to the region of the underside of the valve where it becomes entrained with water being discharged through the valve.

The valve and bucket of this embodiment may be as described herein.

The advantage of this embodiment of the invention is that the inner side of the bucket does not become contaminated by retardant. Accordingly the bucket is significantly less likely to contaminate dip sites. This embodiment is predicated on the

observation that the preferred valve construction of the invention enables the retardant to become entrained with the water as the water flows from the bucket. As the water passes through the venturi throat created by the distortion of the valve, the pressure differential created by the venturi effect has been observed to draw retardant towards the flow path of the water being discharged.

The reservoir may take any suitable form capable of holding a fire retardant such as a foam, a liquid chemical retardant, or a gas. The reservoir will typically be located externally of the bucket. Preferably the reservoir will be capable of delivering the retardant to the underside of the valve by a gravity feed.

The release means may take any suitable form. In one typical embodiment the release means comprises one or more valves. The valves will typically be solenoid valves.

The apparatus of this embodiment may be provided with a sensor to sense the level or weight of water in the bucket. The sensor may in one embodiment comprise a pressure sensitive device which causes the valve to close when the bucket weight falls below a predetermined level set by the pilot. The pressure sensitive device may in one embodiment comprise a pressure sensing transducer capable of sensing the bucket weight and which allows the bucket to be filled automatically to a predetermined volume. The pilot's cockpit will typically be fitted with a visual or audible indicator to indicate to the pilot the volume level in the bucket.

In one typical embodiment of this aspect of the invention a switch is provided to restrict the flow of retardant from the reservoir when the bucket has been emptied to a predetermined level. The balance of the water remaining in the bucket may be used to clean the release means of retardant as the balance of the water is discharged onto a fire. A typical example provides for the discharge of approximately 75% of the water from the bucket, with the approximately 25% remaining being used to cleanse the release means.

The variable load capacity for the bucket provided by the invention may be achieved by observing that hydraulic pressure is directly proportional to the weight in the bucket. The hydraulic pressure may in one embodiment be measured by an electric transducer and passed to a variable voltage regulator and in turn a relay for valve open and valve closed operation. When hydraulic pressure (and therefore bucket weight) falls below a predetermined level selected by the pilot, the valve will be caused to close, trapping that quantity of water in the bucket.

The aircraft may be a fixed wing aircraft or it may be rotor-driven. Typically the aircraft will be a helicopter.

The bucket according to the invention may take any suitable form. Typically the bucket will taper upwardly and outwardly so that the bucket has a relatively wide mouth as compared to the base of bucket. This manner of construction has been observed to assist with maximising the efficacy of the scooping action of the bucket, and hence the amount of water the bucket can hold.

The bucket may be formed from any suitable material(s). Preferably, the bucket is formed from flexible material to enable it to be folded and stored (such as in an aircraft baggage compartment or in the cockpit) when not in use. In one typical embodiment the side walls of the bucket body are formed from a pliable substantially waterproof material. This construction not only contributes to the light weight of the bucket but also facilitates collapsing of the bucket vertically for storage. A typically preferred material for forming the side walls of the bucket is known as "Complas 900" having weldable webbing. The bucket may be provided with structural rigidity by releasable internal or external battens or spokes. The battens or spokes will typically collapse radially to approximately the diameter of the bucket base for transportation and storage. Preferably the base of the bucket will be substantially rigid.

The valve of the bucket located in the region of the base of the bucket for permitting the contents of the bucket to be discharged from the bucket may take any suitable form. The valve may be actuated by mechanical or electronic means. In a preferred embodiment opening and closing of the valve is achieved by relative movement of the bucket with respect to the valve and by the weight of water in the bucket as described herein.

The valve will typically have at least one leaf capable of varying the state of the bucket base between an open and a closed condition.

In one embodiment the valve assembly comprises a valve body in the form of a substantially planar resiliently flexible disc mounted in a frame. In a particularly preferred embodiment, the valve body is in the form of a disc comprising a pair of leaves or wings capable of flexing about a substantially central hinging region. The leaves may be provided with one or more score lines, flex points or lines of weakness to facilitate temporary distortion of the leaves.

In a preferred embodiment the leaves are capable of distorting in a downward direction in response to water pressure to permit a change of state of the valve.

The valve is in a preferred embodiment attached to the aircraft by means of a stay, line or cable. In a particularly preferred embodiment a substantially central stay is

provided to support the valve, the central stay also being connected to the aircraft. The central stay is attachable to the valve by means of a pair of short stays which extend outwardly and downwardly from the central stay and are attached in the region of opposed peripheral edges of the valve.

The valve is accordingly capable of flexing upwardly or downwardly in response to a change in the weight of water in the bucket.

The valve body may be formed from any suitable material. In one typical embodiment the valve body is formed (such as by moulding) from a resilient polymer material or a mixture of polymer materials. One preferred polymer material is polyurethane. The polymer materials may have different densities. Other valve body materials are envisaged within the scope of the invention.

The valve frame may be formed from any suitable material. One preferred material is steel. A typical frame can be constructed in a preferred embodiment from a zinc plated mild steel.

In a typical embodiment of the invention the valve is capable of being remotely actuated by the pilot from the cockpit of the aircraft. Actuation of the valve may be by any suitable means. In one particularly preferred embodiment, the actuator comprises an electric over hydraulic system having a plurality of hydraulic cylinders and which uses the weight of the water in the bucket to store energy and to use that energy (in effect, gravity) to release the water on command. The hydraulic cylinders do not require hydraulic pumps, electric motors or bleed air in order to function. A nitrogen accumulator will typically be used to reset the cylinders before the bucket is refilled.

The actuator is preferably located in a region which is remote from the wet area of the bucket. The actuator will typically be attached to cable supports for the bucket, which then connects the actuator directly to the suspension hook of the aircraft or to an extension long line.

Typically there will be a plurality of electric solenoids to control the valve in the open or closed sequence. The arrangement may be such as to include a manual override function so as to release water in the event of an electrical or other failure.

In one typically preferred embodiment, the valve arrangement comprises a butterfly valve and actuator. When the valve is caused to open by the actuator, the resultant pressure of water discharging through the valve causes the valve to distort, which facilitates the rapid discharge of water.

Preferably, the butterfly valve is of a substantially circular configuration having a pair of leaves or wings joined by a hinge. The presence of the central hinge region and plurality of flexible stress points located on each of the leaves or wings of the valve assist the valve to distort under pressure when the valve is opened. A particular advantage of preferred embodiments of the present invention is that the venturi effect, or an effect approximating a venturi effect, is caused by the water pressure in the bucket and not by virtue of the requirement to mechanically lift the valve leaves or wings by a cable.

The bucket may be suspended from the aircraft by any suitable means as is known in the art. This includes slings, cables, harnesses and cradles. The bucket will typically include hooks or other attachment points to facilitate suspension from the hook of the aircraft. Typically, the manner of suspension will be by means of one or more cables or harnesses forming a connection between the rim of the bucket body and a point of attachment on the aircraft. Preferably the supports will be distributed substantially evenly around the bucket rim to assist with the stability of the bucket during transportation by air. The supports will preferably be releasable for storage with the bucket when not in use.

The rim of the bucket may include one or more emergency attachment points to enable equipment or persons to be attached to the bucket and lifted out of a danger situation. The attachment points may be capable of having an attachment mechanism such as a carabina (often part of a fire or other safety worker's apparel) attached to them.

As an added safety feature of the invention, the base of the bucket, of which the valve forms a part, may in one embodiment have sufficient rigidity to support cargo, for example fire fighting equipment. The base may include a fail-safe device to ensure that the valve does not open when cargo is being carried inside the bucket.

The apparatus of the present invention allows the pilot to automatically and accurately adjust, from the cockpit, the amount of water being lifted in flight. This obviates the need to land the aircraft and make manual adjustments to the bucket. This not only improves safety but allows the aircraft to remain "on fire" longer as more fuel can be loaded initially. As fuel burns off more water can be added to the bucket.

In one particularly preferred embodiment the present invention provides a fire fighting apparatus comprising:

(a) a tapered bucket capable of being suspended from an aircraft, the bucket having an open upper end to enable the bucket to be filled;

(b) a valve located in the region of the base of the bucket for permitting the contents of the bucket to be discharged from the bucket remotely by the aircraft pilot;

(c) a reservoir for a fire retardant, the reservoir having release means which when activated permits the flow of retardant to the region of the underside of the valve where it becomes entrained with water being discharged through the valve, and

(d) sensing means to dynamically sense the weight and/or level of water in the bucket to enable the bucket to be filled or discharged to a pre-determined volume by the pilot..

The valve and bucket of this embodiment may be as described herein.

In this embodiment the valve may be a remotely actuated valve located in the region of the base of the bucket for permitting a controlled volume of the bucket load to be discharged by the aircraft pilot.

The valve of this embodiment may be a resiliently flexible valve located in the region of the base of the bucket for permitting the contents of the bucket to be discharged from the bucket remotely by the aircraft pilot, the valve being sufficiently flexible to enable it to be distorted under pressure when the valve is open.

Description of the drawings

The present invention will now be further described with reference to particularly preferred embodiments in which:

Figure 1 is a perspective view from above of a fire fighting apparatus according to one embodiment of the invention;

Figure 2 is a perspective cross-sectional view of the fire fighting apparatus of Figure 1, and

Figure 3 is a perspective view from above of a fire fighting apparatus according to another embodiment of the invention.

Detailed description of the Invention

Turning to the drawings, Figure 1 shows a fire fighting apparatus 10 in the form of a tapered bucket 11 having an open upper end 12, a base 13 and a rim 14. Attachment points 17 are provided around the rim 14 to facilitate attachment of the bucket 11 to an aircraft (not shown).

The bucket 11 is capable of being suspended from an aircraft such as a helicopter (not shown) by means of cables 15 connecting the bucket to an attachment point (also not shown) such as a sling hook on a helicopter.

The bucket 11 is capable of holding a definable volume of water to be transported to the site of a forest fire for discharge. The bucket 11 may be of any suitable shape including a cylindrical shape or, as in the embodiment shown, a frustoconical shape tapering upwardly and outwardly.

The side walls of bucket 11 are constructed from a flexible substantially water-proof material such as Complas 900™. Weldable webbing reinforces the Complas for vertical and horizontal strength. The base 13 of the bucket 11 is substantially rigid.

A plurality of radial battens or spokes 18 are provided on the bucket 11 to provide rigidity to the bucket 11. The battens or spokes 18 allow the top of the bucket to collapse radially to the diameter of the solid base to allow for storage.

The support cables 15 for attaching the bucket 11 to the helicopter will be substantially as known in the art. Typically these can include ropes, harnesses, wire cables or other suitable materials. The bucket 11 in the embodiment shown is suspended from the sling hook by the cables which are attached to eight equally spaced points on the bucket body rim. It will be noted from the Figures that valve stay 16 is attached to the valve and attachable to the aircraft, but is not otherwise attached to the bucket 11. In this embodiment, separate lines, stays or cables 15 are provided for attaching the bucket to the aircraft. This allows for independent relative movement of the bucket with respect to the valve 20.

As can be seen from Figure 2, the base includes a discharge valve 20 which in the specific embodiment shown is a butterfly –type valve and actuated remotely by means of cable 16. Valve 20 is formed from of a rigid material and in the embodiment shown comprises a polyurethane disc mounted within a zinc plated mild steel frame. The polyurethane disc is moulded from 2 polyurethane densities, the first designated 80A which is flexible and the second designated 80D which is rigid. 80A allows easy bending and forms the flexible hinge point 21 for the valve 20. The 80D rigidity provides strength, preventing the valve 20 from pushing through the steel frame when under water pressure. In use when the valve 20 is opened, the disc bends at the flexible hinge point 21 and its peripheral edges flex downwardly. Other opening arrangements of the valve are considered to be within the scope of the invention.

The valve 20 has additional flexible stress points 22 moulded into the 80D polyurethane and parallel with the centre hinge point 21. These areas allow the valve 20 to distort under pressure when the valve 20 is in an open state.

In a filling or transport phase, the valve stay and the bucket lines are held in a fixed position relative to one another.

In a bucket discharge phase, the bucket lines 15 are slackened or extended so that the bucket 11 falls relative to the valve 20. By virtue of the fixed position of the valve 20 in space relative to the bucket 11 and by virtue of the tapering of the bucket 11, a gap forms between the outer periphery of the valve 20 and a side wall of the bucket 11. The weight of the water which starts to pass through the gap has the effect of distorting the valve periphery in a downward direction, creating an effect approximating a venturi effect in the region between the valve periphery and a side wall of the bucket 11.

Alternatively, the opening of valve 20 may be controlled by shortening cable 16 remotely.

The valve 20 is controlled by means of a remotely operated actuator 19 through cable 16, which together with the valve 20, constitutes the valve assembly. The actuator 19 attaches to the top of the bucket cable supports 15, remote from the wet area of the bucket body. It connects either directly to the helicopter sling or to an extension long line.

The actuator 19 is an electric over hydraulic system using the weight of water in the bucket to store energy and using this stored energy to release the water on command.

The two hydraulic cylinders do not require hydraulic pumps, electric motors or bleed air function as with other prior art apparatus. There are 2 electric solenoids to control the valve in an open or closed sequence. There is an optional manual override to release water in the event of electrical failure. A nitrogen filled accumulator resets the cylinders before bucket refill.

A pressure sensitive transducer (not shown) senses bucket weight and allows the bucket to be filled automatically by the pilot to a pre-determined volume. The hydraulic pressure is directly proportional to the weight in the bucket 11. Hydraulic pressure is measured by an electric transducer and passed to a variable voltage regulator and in turn a relay for valve open/valve closed operation. When hydraulic pressure (and therefore bucket weight) falls below a predetermined level (selected by the pilot) the valve 20 will close, trapping that quantity of weight in the bucket 11.

As shown in Figure 3, foam reservoir 23 is mounted externally of the bucket 11 near the actuator 19. A gravity feed line 24 transfers foam chemical from the reservoir 23 in the direction of the arrow A to the valve 20 via 4 water level controlled flow solenoids 25 and a single flexible plastic line. The solenoid valves are electric and are mounted

close to the centre hinge point 21 of the valve 20. When activated, the solenoid valves allow foam to flow from the foam reservoir 23 to the underside of the valve 20 through a hole in valve 20.

As water streams from the bucket 11, passing through the venturi throat, the low pressure area created from the venturi effect draws foam from the solenoid valves. A water level switch senses when the bucket is 75% empty and restricts the flow of foam from the reservoir. The remaining 25% of water then cleans the solenoid valves of foam. As a result of this arrangement, the bucket is not contaminated by foam and therefore will not contaminate dip sites.

The bucket body can be fitted with 4 x 500lb/230 kg emergency attachment points 17 fitted at the rim 14 of the bucket 11. In an emergency the empty bucket can be used as a transport vehicle to remove cargo from an approaching fire front. Evacuees of a fire can attach a carabina directly to an attachment point 17. Cargo can be carried inside the bucket.

The word 'comprising' and forms of the word 'comprising' as used in this description does not limit the invention claimed to exclude any variants or additions.

Modifications and improvements to the invention will be readily apparent to those skilled in the art. Such modifications and improvements are intended to be within the scope of this invention.

Geoff Hall and Mark Robertson 4 September 2002

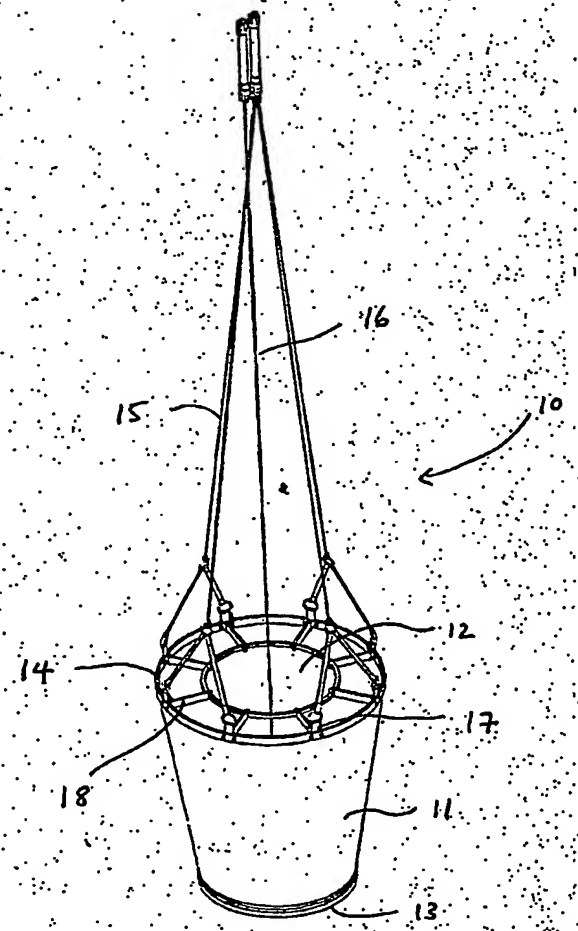

FIGURE 1

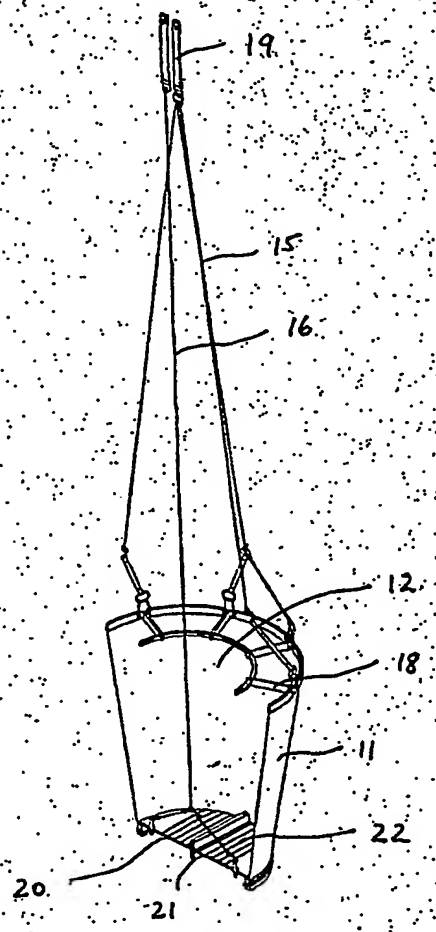

FIGURE 2

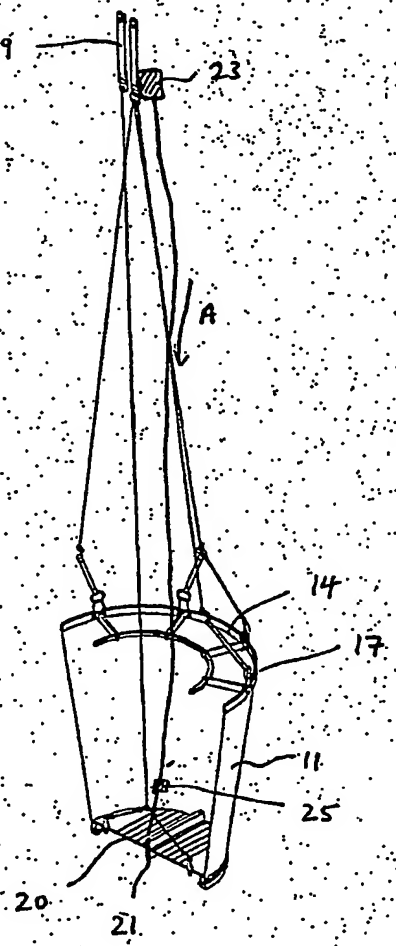

FIGURE 3